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DIVERSITY, DISTRIBUTION, AND STATUS OF ORCHIDS IN UPPER BEAS CATCHMENT AND PARBATI VALLEY OF KULLU DISTRICT, HIMACHAL PRADESH

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Abstract

The Indian Himalayan Region (IHR) is the most complex and diversified mountain ecosystem and occupies a special place in the world and covering an area about 5 lakh km^2, spreading on 10 states and hill regions of 2 states and 95 districts of the Indian subcontinent and contributes about 16.2% of the total geographical area of the country. The great variation in topogeographical features causes immense diversity in climate and habitat conditions within the region. Nestled and nurtured in the laps of the NorthWestern Himalaya, Kullu district is a veritable jewel in the crown of Himachal Pradesh, and is rich in floral and faunal diversity. It supports representative, natural, unique and socio-economically important biodiversity. The present study has been conducted in Upper Beas Catchment and Parbati Valley of Kullu District of Himachal Pradesh. During the exploration of floral diversity in the selected sites, the intensive survey and sampling of the orchids were also done with a view to study their diversity, distribution, and status. Rapid sampling for the qualitative assessment and quadrat method for the quantitative assessment have been followed. Total 18 species representing 12 genera were recorded, of these, 12 species were recorded from Upper Beas Catchment and 18 species were recorded from Parbati Valley. The species were analyzed for nativity, indigenous uses and threat categories. Amongst the species of both the valleys, 1 species was endemic and 2 species were near endemic; 15 native and 3 species were non-natives to the Indian Himalayan Region. Out of the total 18 species recorded, 12 species were found in the sampled sites for quantitative assessment. In Upper Beas Catchment, density of the species varied (*Calanthe tricarinata* 0.25-0.80 Ind m^{-2}, *Cephalanthera longifolia* 0.05 Ind m^{-2}, *Dactylorhiza hatagirea* 0.06-0.40 Ind m^{-2}, *Epipactis helleborine* 0.44 Ind m^{-2}, *Goodyera fusca* 0.07 Ind m^{-2}, *G. repens* 0.24 Ind m^{-2}, *Habenaria edgeworthii* 0.30-0.45 Ind m^{-2}, *H. pectinata* 0.01 Ind m^{-2}, *Herminium lanceum* 0.50-0.75 Ind m^{-2}, *H. monorchis* 0.35 Ind m^{-2}, *Malaxis acuminata* 0.01 Ind m^{-2}, and *Malaxis muscifera* 0.06-0.65 Ind m^{-2}). In Parbati valley, density of the species also varied (*Calanthe tricarinata* 0.55-0.80 Ind m^{-2}, *Cephalanthera longifolia* 0.05 Ind m^{-2}, *Cypripedium cordigerum* 0.05-0.88 Ind m^{-2}, *C. himalaicum* 0.11 Ind m^{-2}, *Dactylorhiza hatagirea* 0.05-0.15 Ind m^{-2}, *Epipactis helleborine* 0.09-0.77 Ind m^{-2}, *Galeola lindleyana* ranged from 0.10-0.33 Ind m^{-2}, *Goodyera fusca* 0.23 Ind m^{-2}, *G. repens* 0.19 Ind m^{-2}, *Habenaria edgeworthii* 0.25-0.55 Ind m^{-2}, *H. intermedia* 0.22-0.45 Ind m^{-2}, *H. pectinata* 0.07-0.35 Ind m^{-2}, *Herminium lanceum* 0.60-0.95 Ind m^{-2}, *H. monorchis* 0.20-0.55 Ind m^{-2}, *Malaxis acuminata* 0.06-0.50 Ind m^{-2}, *M. muscifera* 0.06-0.17 Ind m^{-2}, *Satyrium nepalense* 0.22 Ind m^{-2}, and *Spiranthes sinensis* 0.18 Ind m^{-2}). In both valleys, 3 species were identified as critically endangered; 2 species were identified as endangered, 3 species were as vulnerable and rest were near threatened. Some of the species have medicinal properties and used in the treatment of obstructive pulmonary diseases, chronic gastroenterological disorder, paralysis, arthritis, syphilis, jaundice, hepatitis, cholera, piles, bone fractures, rheumatism, malaria, cervix and breast cancer, cuts and wounds, dermatological diseases, gynecological malfunctioning, tuberculosis, blood purification, diabetes and also as rejuvenating drugs. The unscientific exploitation of economically important orchids, habitat degradation and changing environmental conditions has led the population towards depletion. Monitoring of habitats and populations, promotion of propagation by conventional and *in vitro* methods, establishment in the *ex situ* and *in situ* conditions, awareness among the inhabitants and involvement of the local inhabitants in the conservation management have been suggested.

Introduction

ORCHIDACEAE IS diverse and widespread family of flowering plants; it has often colourful and fragrant blooms. The orchids are the most wonderful creation by nature and represent a highly evolved group of flowering plants. This family comprises more than 22,000 species worldwide and is the second largest family, after Asteraceae. In India, orchidaceae is represented by 1141 species, 657 of which are epiphytic and 484 terrestrial in habit; some are lithophytic as well. The Indian Himalayan Region (IHR) supports 8000 flowering plants and the family orchidaceae is considered as one of the species rich families of angiosperms (Samant, 2002; Singh and Hajra, 1996). Like other parts of IHR, orchids of Himachal Pradesh are well known for their charming beauty and utility. Upper Beas Catchment and Parbati Valley represent unique diversity of orchids, although the richness is relatively very low. These areas have great variation in topogeographical features *i.e.*, large altitudinal range, diverse habitats and aspects which causes immense diversity in climate and habitat conditions within the region. The orchids are highly

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specialized and require specific habitats and circumstances for their growth and development. In fact, they are more vulnerable to habitat loss and environmental degradation, thus orchids states the fitness of a given ecosystem and are considered as the indicator plants. Despite their ecological and socio-economical importance, a limited number of studies have been carried out on orchids in Himachal Pradesh (Deva and Naithani, 1986; Pathak *et al.,* 2010; Samant, 2002; Vij *et al.*, 1982). According to Weston *et al*. (2005), land clearance and altered land use practices that detrimentally affect the orchid habitats, are major factors responsible for local extinction of species. To conserve orchids in their natural habitats, there is a need to conduct studies on orchid ecology (Weston *et al.*, 2005). Geo-dynamically, the young mountains of these regions are still unexplored for unique orchid diversity especially qualitatively and quantitatively. Therefore, the present study has been made to: i) assess the diversity of orchids of Upper Beas Catchment and Parbati Valley; ii) assess the indigenous uses of orchids; iii) assess the orchid diversity for nativity and endemism, and threat categories; and iv) suggest strategy and action plan for conservation.

Materials and Methods

Study Area

The State Himachal Pradesh (30°22'4" to 33°12'40" North latitudes and 75°47'55" to 79°04'20" East longitudes) covers the parts of Trans and NorthWestern Himalaya. It is bounded by Tibet in East, Jammu and Kashmir in the North, Uttarakhand in the SouthEast, Haryana in the South and Punjab in the West. Physiographically, it is divided in three conspicuous zones, namely outer Himalaya or the Shivaliks, inner Himalaya or mid mountain and the greater Himalaya or alpine zones. It is known for its healthy climate and experiences considerable deviations in the distribution of rainfall and temperature due to varying aspects and altitude, precipitation declines from East to West and South to North. Upper Beas Catchment (32°17' 34.82"-32°22'15.61" N latitudes and 77°10' 15.61" -77°14' 41.49" E longitudes and altitudinal range, 2000–6001m amsl) and Parbati Valley (31°53' 48.41" - 32°04' 22.70" N latitudes and 77°09' 01.81" - 77°18' 34.41" E longitudes and altitudinal range, 1113–6632m amsl) of Kullu district, Himachal Pradesh were selected for the study. These sites support unique topographical gradients, diverse vegetation and support

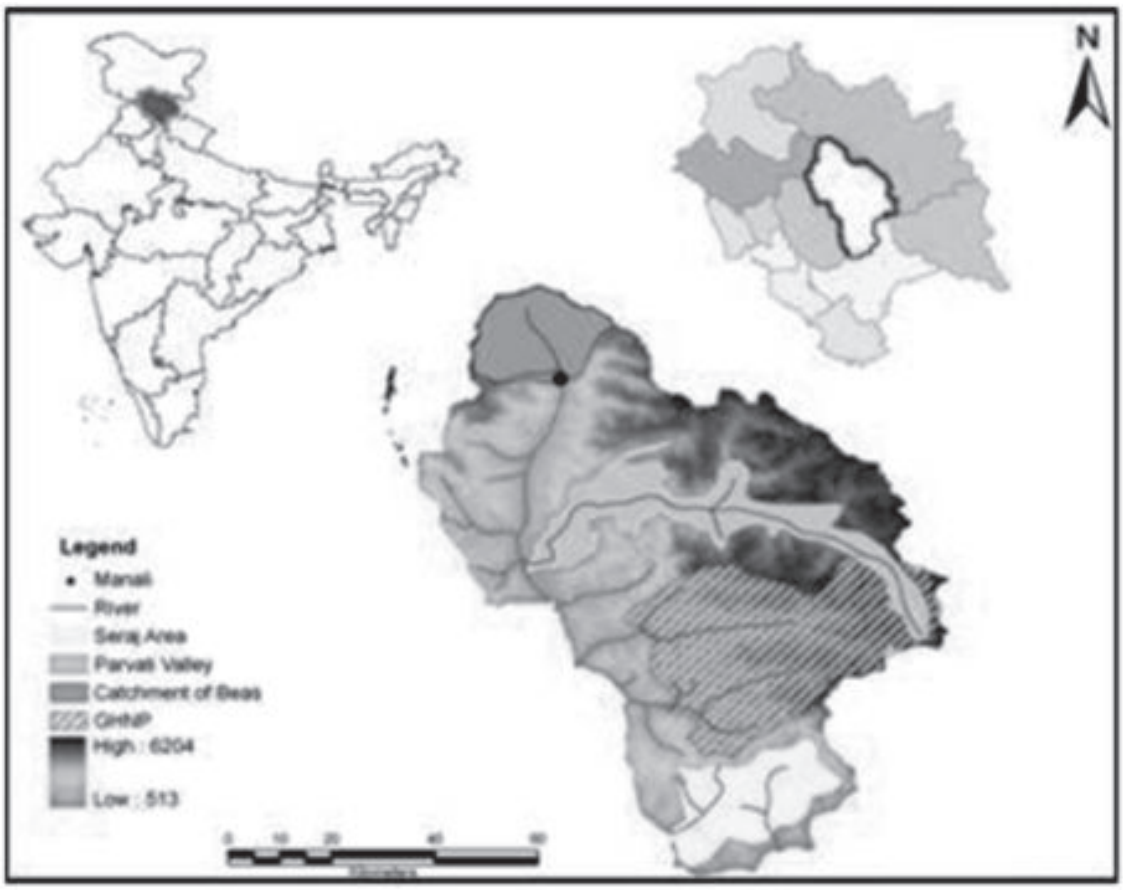


Fig. 1. Map of the study area.

a large number of mammals and birds. The study areas are well known for diverse habitats, climatic conditions and rich biodiversity. Both the areas have a large altitudinal range inhabited by a number of villages in all the accessible aspects and habitats, and is mainly dominated by sub–tropical, temperate and sub- alpine broad leaved and coniferous forests, alpine scrubs and alpine herbaceous vegetation. Winter experiences severe cold and main precipitation in the form of snow. Rains are mostly confined to summer and rainy seasons. The inhabitants are largely dependent on natural resources for their sustenance. Due to various anthropogenic activities and sensitivity of the area for various risks and hazards, and climate, the most components of biodiversity in the area are under tremendous pressure.

Methodology

Selection of Sites and Habitats

The sites were selected and surveys were conducted on each and every accessible aspect along an altitudinal gradient in Upper Beas Catchment and Parbati Valley during the summer season of 2014-2015. Extensive surveys were conducted for the qualitative and quantitative assessment of orchids. The habitats were identified based on physical characters and dominance of the vegetation. Plots having closed canopy with high percentage of humus and moisture were considered as moist habitats, whereas low percent of the same as dry habitats. The plots having >50% boulders of the ground cover were classified as bouldery habitat. The plots near to Nallah or Khad or river were considered as riverine. The sites which had e" 60% rocks were considered as rocky habitat and those facing high anthropogenic pressures were classified as degraded habitat.

Surveys, Sampling, Identification, and Analysis of Data

Rapid floristic survey assessment and quadrat methods were used. The rapid sampling of the species was done and the samples of each species were collected for proper identification. Information regarding habitats, altitudinal range *etc.* was collected. The species were identified with the help of flora and literature (Deva and Naithani, 1986; Dhaliwal and Sharma, 1999; Duthie, 1906; Pangtey *et al.*, 1991; Samant, 1993; Singh and Rawat, 2000). The field surveys and samplings were conducted in the selected sites along an altitudinal gradient. In each site, a plot of 50 × 50m was laid and within this plot 20 quadrats of 1 × 1m were laid randomly. The data were analyzed for density. For the assessment of economically important biodiversity, local Vaidhyas and knowledgeable persons from each village were interviewed, irrespective of their age or gender. The information was compiled and analyzed for the utilization pattern following Samant *et al.* (2007). Species were analyzed for nativity and endemism. The nativity of the species was identified following Anonymous (1883-1970), Samant (1999), Samant and Dhar (1997), Samant *et al.* (1998, 2000, 2002). Endemism of the species was identified based on distribution of the species (Dhar and Samant, 1993; Samant, 1999; Samant and Dhar, 1997, and Samant *et al.*, 1996, 1998, 2000). The threat categorization of the species was done based on the cumulative values of habitat preference, population size, distribution range, anthropogenic pressures including use values and extraction trends, nativity, endemism, *etc.*, and following Rana and Samant (2010), Samant and Pal (2003), Samant *et al.* (1998), and Ved *et al.* (2003). Categorization of these species as Critically Endangered, Endangered, Vulnerable, *etc.*, has also been done following Rana and Samant (2010).

Results

Diversity and Distribution

A total of 18 species representing 12 genera (*Calanthe, Cephalanthera, Cypripedium, Dactylorhiza, Epipactis, Galeola, Goodyera, Habenaria, Herminium, Malaxis, Satyrium* and *Spiranthes*) were recorded, of these, 12 species were recorded from Upper Beas Catchment and 18 species were recorded from Parbati

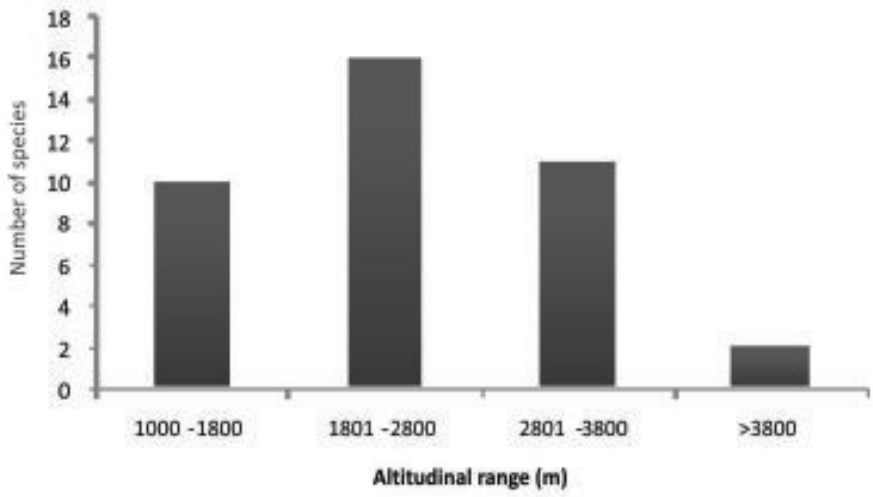


Fig. 2. Altitudinal distribution of the orchids.

Valley. Among genera, *Habenaria* (3 species) and *Cypripedium, Goodyera, Herminium* and *Malaxis* (2 species each) were dominant. These Orchid species were found in diverse habitats *i.e.,* shady moist, moist, dry alpine slope, moist alpine slope, bouldery, *etc.* Orchids were recorded from the sub-tropical to alpine zones. Maximum diversity of orchids was found in temperate zone of the study sites.

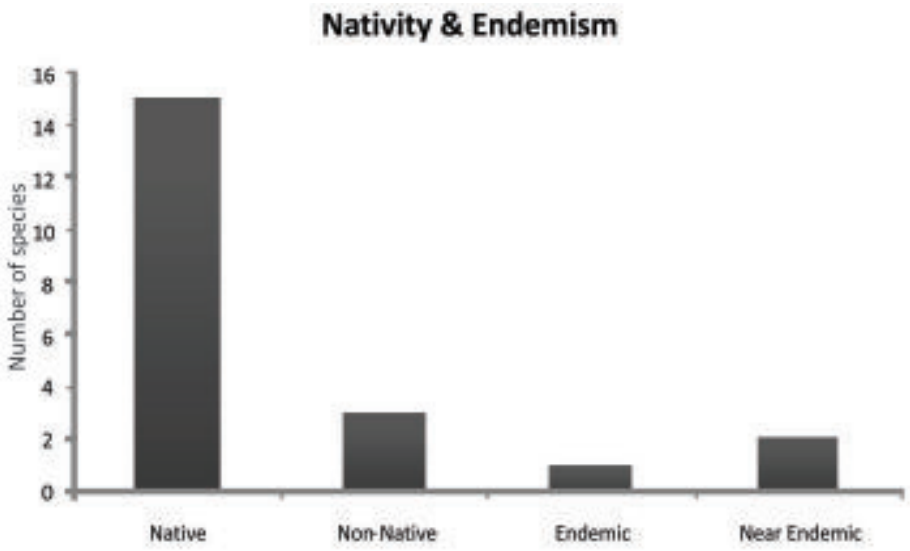


Fig. 3. Diversity of native, non-native, endemic and near endemic orchids of the Upper Beas Catchment and Parbati Valley.

Density

In the Upper Beas Catchment, density of the species varied (*Calanthe tricarinata* 0.25-0.80 Ind m^{-2}, *Cephalanthera longifolia* 0.05 Ind m^{-2}, *Dactylorhiza hatagirea* 0.06-0.40Ind m^{-2}, *Epipactis helleborine* 0.44 Ind m^{-2}, *Goodyera fusca* 0.07 Ind m^{-2}, *G. repens* 0.24 Ind m^{-2}, *Habenaria edgeworthii* 0.30-0.45 Ind m^{-2}, *H. pectinata* 0.01 Ind m^{-2}, *Herminium lanceum* 0.50-0.75 Ind m^{-2}, *H. monorchis* 0.35 Ind m^{-2}, *Malaxis acuminata* 0.01 Ind m^{-2}, and *M. muscifera* 0.06-0.65 Ind m^{-2}).In Parbati Valley, the densityalaso varied (*Calanthe tricarinata* ranged from 0.55-0.80 Ind m^{-2}, *Cephalanthera longifolia* 0.05 Ind m^{-2}, *Cypripedium cordigerum* 0.05-0.88 Ind m^{-2}, *C. himalaicum* 0.11 Ind m^{-2}, *Dactylorhiza hatagirea* 0.05-0.15 Ind m^{-2}, *Epipactis helleborine* 0.09-0.77 Ind m^{-2}, *Galeola lindleyana* 0.10-0.33 Ind m^{-2}, *Goodyera fusca* 0.23 Ind m^{-2}, *G. repens* 0.19 Ind m^{-2}, *Habenaria edgeworthii* 0.25-0.55 Ind m^{-2}, *H. intermedia* 0.22-0.45 Ind m^{-2}, *H. pectinata* 0.07-0.35 Ind m^{-2}, *Herminium lanceum* 0.60-0.95 Ind m^{-2}, *H. monorchis* 0.20-0.55 Ind m^{-2}, *Malaxis acuminata* 0.06-0.50 Ind m^{-2}, *M. muscifera* 0.06-0.17 Ind m^{-2}, *Satyrium nepalense* 0.22 Ind m^{-2} and *Spiranthes sinensis* 0.18 Ind m^{-2})

Nativity and Endemism

Fifteen species namely, *Calanthe tricarinata, Cephalanthera longifolia, Cypripedium cordigerum, Dactylorhiza hatagirea, Epipactis helleborine, Goodyera fusca, Habenaria edgeworthii, H. intermedia, H. pectinata, Herminium lanceum, H. monorchis, Malaxis acuminata, M. muscifera, Satyrium nepalense* and *Spiranthes sinensis* were found to be native; 3 species non natives; 2 species *i.e., Habenaria pectinata* and *Satyrium nepalense* near endemic and one species, *Habenaria edgeworthii* was endemic to the Indian Himalaya (Table 1).

Indigenous Uses

Different plant parts *i.e.,* leaves and tubers (6 species each), aerial parts (5 species), rhizomes (3 species), bulbs and roots (2 species) and stem (1 species) were used by the inhabitants for various therapeutic uses. Five species were used as energizing tonic and aphrodisiac, 4 species as blood purifier, 3 species used to treat cold, cough, fever and joint pains, and 2 were used as antidiabetic. For instance, tubers of *Dactylorhiza hatagirea* were used as a farinaceous food and used to treat fever and various other body disorders, powder of tubers of *Habenaria edgeworthii* was considered to be blood purifier and *H. pectinata* was used for joint pains. Tubers of *Epipactis helleborine* were used to treat insanity, gouts, headache and stomachache. Aerial parts of *Goodyera fusca* were considered as very good appetizers. *Malaxis acuminata* was used for curing arthritis, blood purification and as as aphrodisiac. *Malaxis muscifera* was used as tonic and aphrodisiac. Extract of *Herminium lanceum* was given to cure suppressed urination. Health tonic was made from *Herminium monorchis*. Likewise, other species were used in the treatment of obstructive pulmonary diseases, chronic gastroenterological disorder, paralysis, syphilis, jaundice, hepatitis, cholera, piles, bone fractures, rheumatism, malaria, cervix and breast cancer, cuts and wounds, dermatological diseases, gynaecological malfunctioning, tuberculosis, diabetes and also as rejuvenating drugs. (Table 1).

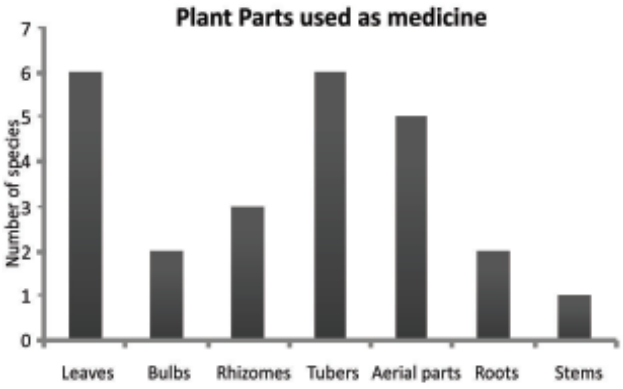


Fig. 4. Parts used of medicinally important orchids.

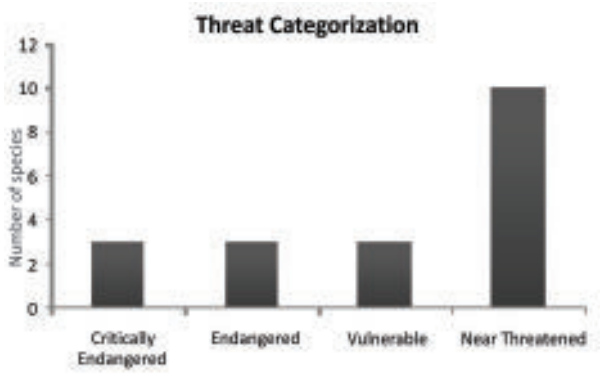


Fig. 6. Number of threatened orchids.

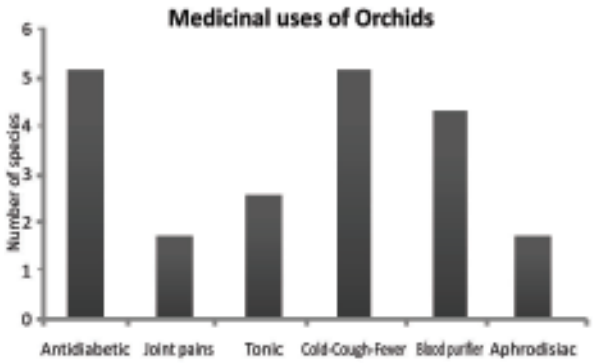


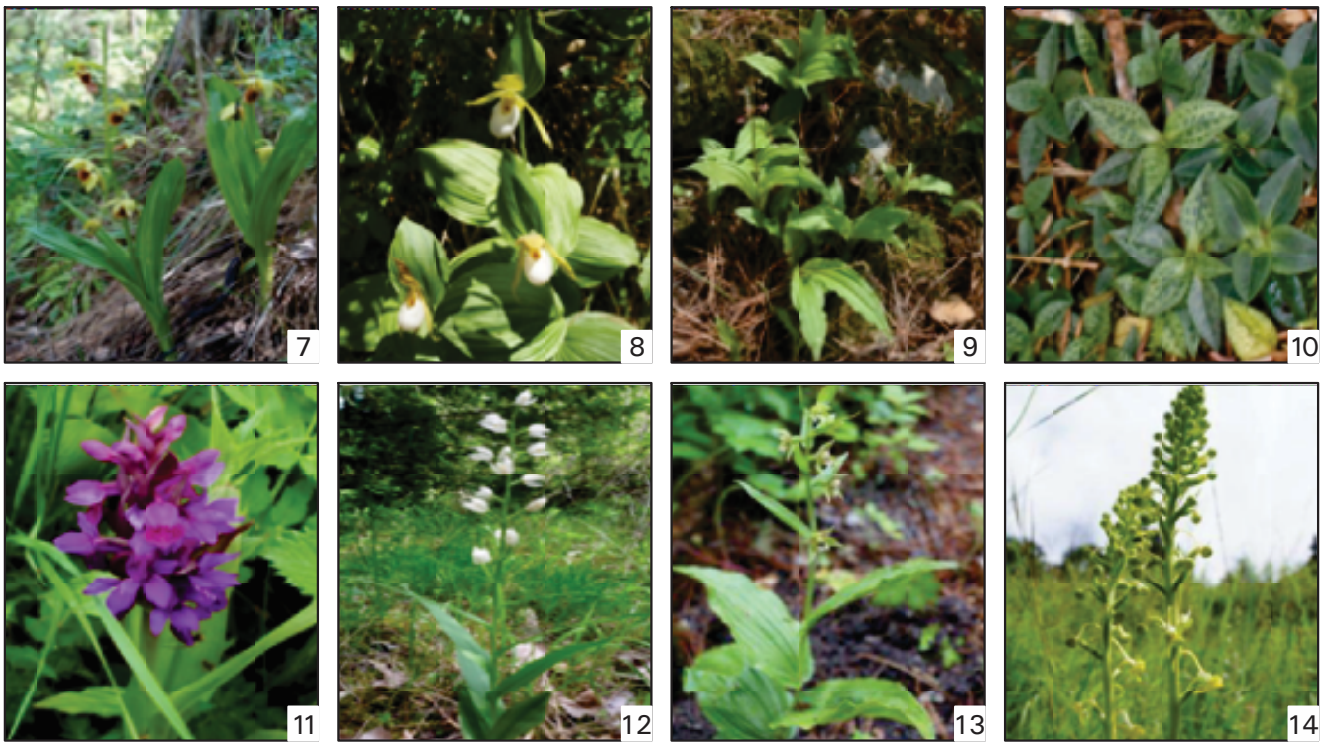
Fig. 5. Number of medicinal uses of orchids.

Threat Categorization

Analysis of threat categorization revealed 3 species *i.e.*, *Dactylorhiza hatagirea, Herminium monorchis,* and *Malaxis muscifera* as Critically Endangered (CR); 3 species *i.e.*, *Cypripedium himalaicum, Habenaria edgeworthii,* and *Malaxis acuminata* as Endangered (EN); 3 species, *Habenaria pectinata, Herminium lanceum,* and *Spiranthes sinensis* Vulnerable (VU) and rest were Near Threatened (NT).

Discussion

The Indian Himalayan Region (IHR) is known for the rich orchid diversity, particularly the Central and



Figs. 7-14. Orchid species from study area: 7, *Calanthe tricarinata;* 8, *Cypripedium cordigerum;* 9, *Malaxis acuminata;* 10, *Goodyera fusca;* 11, *Dactylorhiza hatagirea;* 12, *Cephalanthera longifolia;* 13, *Epipactis helleborine;* 14, *Habenaria edgeworthii.*

Table 1. Diversity, distribution, indigenous uses, nativity and threat status of orchids in Upper Beas Catchment and Parbati Valley.

Taxa	Occu-rence	Habitat(s)	Altitudinal range (m)	Nativity	Status	Part/s used	Indigenous uses
Calanthe tricarinata Lindl.	1,2	SM, DR	2000-3300	Reg Himal	NT	LF, BL	Used to cure sores and eczema, and as an aphrodisiac
Cephalanthera longifolia (L.) Fritsch	1,2	SM	1700-2500	Reg Himal	NT	TB	Decoction of tubers is given for curing cough and paralysis, also used as tonic and aphrodisiac
Cypripedium cordigerum D. Don	2	SM, M	2100-2800	Reg Himal	NT	RZ, LF	Used for mental disorder
C. himalaicum Rolfe ex Hemsl.	2	M, SM	2000-3000	Europ Afr Bor Or	EN	-	Ornamental
Dactylorhiza hatageria (D. Don) Rolfe	1,2	SM, MAS	2600-3800	Reg Himal Europ Afr Bor Or	CR	TB	Used as an antibiotic, blood purifier, tonic and expectorant and for curing wounds, bone fracture, cough, cold, fever, cuts, sexual disability, rheumatism
Epipactis helleborine (L.) Crantz.	1,2	SM	2500-3600	Reg Himal	NT	LF, RZ, TB	Used to treat insanity, gouts, headache and stomachache; used as an aphrodisiac and used to cure fever; as blood purifier
Goodyera fusca (Lindl.) J.D. Hook	1,2	DAS, BO	2800-3600	Reg Himal	NT	-	-
G. repens (L.) R. Br.	1,2	MAS, SM, M	2500-3000	Reg Himal Bor Temp	NT	AP	Plant paste externally applied in syphilis, extract is taken as a blood purifier
Galeola lindleyana (Hk.f. & Thorn.) Reichb. f.	2	SM, DR	1800-2300	Reg Himal	NT	-	-
Habenaria edgeworthii J.D Hook**	1,2	SM	1500-3000	Reg Himal	EN	TB	Used as a blood purifier and rejuvenator
H. intermedia (J. E.Sm.)D.Don	2	SM, M	1500-2500	Reg Himal	NT	TB	Used in Chyawanprash and in many ayurvedic medicines
H. pectinata D. Don*	1,2	SM	1400-3500	Reg Himal	VU	LF, RT	Used for curing joint pains
Herminium lanceum (Thunb. ex Sw.) Vujik	1,2	SM, MAS	1200-3000	Reg Himal	VU	AP	Used for curing urinary problems
H. monorchis (L.) R .Br.	1,2	SM, RI, MAS	2000-4000	Europ As Bor	CR	AP	Used as tonic
Malaxis acuminata D. Don	1,2	SM	1600-2500	Reg Himal	EN	ST, LF	Used as blood purifier, aphrodisiac, spermopiotic and for curing burning sensation, arthritis
M. muscifera (Lindl.) Kuntze	1,2	SM, MAS	1800-3200	Europ	CR	BL	Used as an aphrodisiac, styptic, and febrifuge; and for curing dysentery, burns, debility, sterility; tonic
Satyrium nepalense D. Don*	2	SM, MAS	1500-3200	Ind Or	NT	TB	Used as energizing tonic, aphrodisiac and for curing

Table 1. Diversity, distribution, indigenous uses, nativity and threat status of orchids in Upper Beas Catchment and Parbati Valley. (contd.)

Taxa	Occu-rence	Habitat(s)	Altitudinal range (m)	Nativity	Status	Part/s used	Indigenous uses
							dysentery and malaria
Spiranthes sinensis (Pers.) Ames	2	SM, DE	1100-2800	China as Temp	VU	TB	Used for curing tuberculosis, debility, snake bite, sore throat, cough, cold, fever, leucorrhea, diabetes

Abbreviations used: 1,Upper Beas Catchment; 2, Parbati Valley; **, Endemic; *, Near Endemic; BO, Bouldery; DR, Dry; DAS, Dry alpine slope; DE, Degraded; M, Moist; MAS, Moist alpine slope; SM, Shady Moist; RI, Riverine; Afr, Africa; As, Asia; Bor, Boreal; Europ, Europe; Himal, Himalaya; Ind, India; Or, Oriental; Reg, Region; Temp, Temperate; Trop, Tropical; CR, Critically Endangered; En, Endangered; NT, Near Threatened; VU, Vulnerable; AP, Aerial Part; BL, Bulb; LF, Leaf; RT, Root; RZ, Rhizome; TB, Tuber; and ST, Stem.

Eastern Himalaya are known as the store house as both the biogeographic provinces support >500 species. Studies carried out on orchids reveal that the diversity of orchids decreases from Eastern Himalaya to the Trans, North-Western Himalaya. (Deva and Naithani, 1986; Pangtey *et al.*, 1991; Samant, 2002, 2009) and this could be due to less humidity in the Trans and North Western Himalaya as the orchids require high humidity particularly epiphytic ones for the growth and development. The present study provides first hand data on orchid diversity of Upper Beas Catchment and Parbati Valley. Most of the species are representative, natural, unique and socio-economically important ones, hence show high conservative value. The diversity of the orchid species decreases with the increasing altitude. Similar trends have been recorded by Samant and this could be probably due to their requirement for specific environmental conditions (Samant, 2009). Apart from the aesthetic values, the orchids are also used in the customary system of medicine, and as food (Samant and Dhar, 1997; Samant *et al.*, 1998). These plants are rich source of alkaloids, flavonoids, glycosides, carbohydrates and phytochemical contents and are used in indigenous systems of medicine to cure different types of human ailments (Pathak *et al.,* 2010; Samant, 2002). In fact, they have been used in the folk lore and other local medicines for past more than 3000 years. Interviewing the local inhabitants of the area revealed that almost all parts of orchids are of high commercial value. Different plant parts such as leaves, tubers, aerial parts, rhizomes, bulbs, roots and stems were used by the inhabitants for various therapeutic uses. Overexploitation of these parts may lead to the extinction of species from the area. The orchid flowers exhibiting an inconceivable range of diversity of size, shape, structure and fragrance, have been well established in floriculture. The mass multiplication of these plants and establishment in floriculture can become one of the livelihood options for the inhabitants. The available stock (*i.e.* density) in the natural habitats revealed significant decrease in population density of orchids. Density of orchids individual/m^2 is relatively poor than the other parts of the Indian Himalaya. IUCN Red lists and Red Data Books, and CAMP workshops have helped in the prioritization of the species and have been playing crucial role in guiding the conservation priorities since long (Goraya *et al.*, 2013; Nayar and Sastry, 1987, 1988, 1990; Ved *et al.*, 2003). But studies on conservation prioritization of orchids following the rule of IUCN guidelines have not been done so far in the region. Threat categorization at local or regional level has been considered as the best approach for developing appropriate strategy and management plan (Rana and Samant, 2010). Having accordance with the same practice, 3 species were designated as Critically Endangered (CR); 3 species as Endangered (EN); 3 species as Vulnerable (VU) and 10 species as Near threatened (NT). Threats to the orchids are due to over exploitation and habitat degradation. The unscientific exploitation of economically important orchids, habitat degradation and changing environmental conditions have led to the population depletion. The populations of *Dactylorhiza hatagirea, Malaxis acuminata* and *M. muscifera* are decreasing rapidly due to habitat degradation and excessive commercial exploitation. Therefore, monitoring of habitats and populations, promotion of propagation by conventional and *in vitro* methods, establishment in the *ex situ* and *in situ* conditions, awareness among the inhabitants and involvement of the local inhabitants and Forest Department in the conservation management have been suggested.

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